Does R&D increase the profit contribution of intangible assets? An exploration of European and American automotive suppliers[*]

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Economic theory implies that research and development (R&D) efforts increase firm productivity and ultimately profits. In particular, R&D expenses lead to the development of intangible assets in the form of intellectual property (IP) and these assets command a return that increases overall profits of the firm. This hypothesis is investigated for the North American and European automotive supplier industries.

Results indicate that R&D expenses in fact increase both intangible asset levels and their profit contributions. In particular, increases in the R&D expense to sales ratio lead to increases in the profit contribution of intangible assets relative to sales. This indicates that more R&D intensive IP should command higher royalty rates per sales when licensed to third parties and within multinational enterprises alike.

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1. Introduction

The effects of R&D investments on productivity have long been the focus of research. There exists consensus theoretically that R&D investments increase productivity both in the aggregate and on the firm level and that is generally confirmed by empirical studies; see e.g. Griliches (1998) and Mairesse/Sassenou (1991) for an overview. However, due to conceptual problems with the central R&D capital model (based on production functions) and econometric problems such as endogeneity and data heterogeneity, much of the empirical work thus far presented remains controversial; see e.g. Griliches (1998), chapter 12.

This investigation does not try to identify the underlying production function but focuses instead directly on the profit and return structure resulting from earlier monetary and tangible capital formation treating the residual difference between the total value of assets of the firm and the sum of monetary and tangible assets as tangible assets or intellectual property (IP) capital. Total profit and return to all assets is then decomposed using the weighted average cost of capital concept to yield a residual profit and return for the IP asset.

Econometric problems of earlier studies are also partly avoided, at least for the American firms, by simply using a much larger data set both across sections (several thousand firms) and within time-series (up to 11 years of average time observations per firm).

I principally follow Clarkson (2001b), who presents a model to test the relationship between the R&D-to-sales ratio and the profit contribution of intangible assets as percentage of sales. He finds that this relationship is significant and positive for the pharmaceutical industry and I apply the same methodology to the European and North American automotive supplier industries. See also Lutz (2013) for an earlier presentation of some of the results.

The remainder of the paper is structured as follows. Section 2 introduces the economic and institutional background, the resulting research questions posed here, as well as the hypotheses to be investigated. The underlying theory is presented in Section 3. Section 4 describes the data used. Section 5 presents the general modeling and summarizes the results. Section 6 concludes. Statistical and econometric results are presented in the appendix.

2. Background and research questions

In general, there is a large body of theoretical and empirical economic research showing that profitability increases with R&D expense; a large part of this is summarized in Hall/Mairesse/Mohnen (2010), Griliches (1998) and Mairesse/Sassenou (1991). The underlying mechanism lies in the build-up of R&D capital – in the form of intangible assets or intellectual property (IP) – as a result of R&D activities. Hall/Mairesse (2009) use Compustat data for about 5600 manufacturing, trade, and services firms for the years 1996 to 2005 and find significant positive effects of past R&D intensity on gross margins and EBIT margins. For the automotive industry, e.g. Jaruzelski et al. (2005) report that firms with above average R&D to sales ratios have on average a greater gross margin than those with below average R&D/sales.

Other research, in turn, establishes a relationship between profit margins and royalty rates; see Kemmerer/Lu (2008) and Goldscheider et al. (2002). For example, using data from RoyaltySource and Compustat for 21 years up to 2007, Kemmerer/Lu report that for a sample of 3800 firms from 14 4-digit SIC industries, average royalty rates lie between 25 percent of gross margin and 25 percent of EBIT margin. Regressing the royalty rates on EBIT margins yields a stable result of 50 percent whereas Goldscheider et al. present the well-known 25 percent rule.

Based on these two bodies of research, it can be shown that profit margins as percentage of sales are increasing in R&D intensities i.e. in R&D spending as percentage of sales. Clarkson

(2001a, 2001b) shows this for the pharmaceutical industry and concludes that increases in R&D intensity lead to increases in the contribution of intellectual property (or intangible assets) to profits measured as percentage of sales (CPIA); a one percent increase in R&D intensity tends to increase CPIA by half a percent.

3. Theoretical Basis

Following Clarkson (2001b) we can write a firm's total cost of capital as:

$$(1)\ WACC = r_i \frac{V_i}{V_t} + r_m \frac{V_m}{V_t} + r_{tan} \frac{V_{tan}}{V_t} = EBIAT/V_t$$

where WACC is the weighted average cost of capital, V_i denotes the value of intangible assets (intellectual property), V_m denotes monetary assets, V_{tan} denotes tangible assets, V_t denotes total assets, r_i denotes return on V_i, r_m denotes the return on V_m, r_{tan} denotes the return on V_{tan}, and EBIAT is profit before interest but after taxes and represents debt-free net income, i.e. net income plus interest expense after tax.

We can now calculate the profit after taxes attributable to intangible assets, PIA, as:

$$(2)\ PIA = EBIAT - r_m V_m - r_{tan} V_{tan},$$

and the contribution of profits due to intangible assets as a share of sales, CPIA, as

$$(3)\ CPIA = \frac{(WACC - r_m \frac{V_m}{V_t} - r_{tan} \frac{V_{tan}}{V_t})}{WACC} * \frac{EBIAT}{sales} = (EBIAT - r_m V_m - r_{tan} V_{\mathrm{tan}})/sales.$$

Given information on WACC, V_t, V_m r_m, V_{tan}, r_{tan} and EBIAT, PIA and CPIA can be calculated. With information on R&D expense and sales, the relationship between CPIA and the R&D expense to sales ratio can be investigated.

The US t-bill rate can be used for measuring r_m and the US t-bond rate for measuring r_{tan} as well as the risk-free rate of interest r_f (used to calculate individual firm WACC values).

The $WACC$ can be calculated as

(4) $WACC = (1 - d_a) * roe + d_a * (1 - t) * r_m$

(5) $V_t = \dfrac{E_i(1-\tau)}{(D_t/V_t)r_i^d(1-\tau) + (1-(D_t/V_t))(r_f + \alpha_i\sigma_i) - g_i} - D_t$

with an assumed average tax rate of t=0.4, d_a is the debt to V_t ratio, D_t is total debt, and roe is the rate of return to equity. Following Damodaran (2011) and Lutz (2011), roe can be expressed by:

(6) $roe = r_f + \alpha * \sigma_{ROE}$

where individual return volatility per firm is calculated as the moving standard deviation of the ratio of net income to total equity.

4. The Data

North-American firm level data comes from Compustat for the NAICS code range 334000 to 336999. The data is yearly from 1950 on with 75% from 1980 on and includes over 5000 firms.

European data comes from Amadeus for NAICs codes 310000 to 339999. The data is yearly from 1998 on and includes over 2400 firms.

Data on short-term and long-term interest rates is taken from the IMF's International Financial Statistics.

A full list of data sources utilized and data obtained is given in Table 1 in the appendix. A list of variables used is given in Table 2 in the appendix.

5. Modeling and results

Econometric modeling

Given the panel data available, we can use the following generalized regression model to investigate the economic hypotheses presented:

$$y_{i,t} = \alpha + \mathrm{B}F_i + \Gamma G_{i,t} + \Delta M_t + \varepsilon_{i,t} + \eta_i \qquad (8)$$

where the dependent variable $y_{i,t}$ is a profit or sales level indicator (e.g. EBIT, sales, or profit margin) of company *i* in period *t*; F_i is a vector of determinants specific to firm i but invariant over time (such as country or industry); $G_{i,t}$ is a vector of determinants that may vary between firms and also over time (e.g., R&D expense); M_t is a vector of period-specific determinants outside of a particular firm (e.g. global economic factors and market indicators); $\varepsilon_{i,t}$ is an idiosyncratic error term that may vary between firms and also over time and is independently distributed with E($\varepsilon_{i,t}$) = 0; and η_i represents unobserved heterogeneity across firms, i.e., a company specific random effect that is independently distributed.

This general specification allows for either random-effects (RE) or fixed-effects (FE) modeling, where the random or fixed effects are firm-specific components. The more general approach is to allow for random firm-specific effects; the case where these effects are fixed, that is determinate constants instead of random variables, is a special sub-case. All model variants reported below were estimated with both FE and RE panel models and with lagged explanatory variables. All models were also run with controls for years, countries and industries (where appropriate).

The data available contains several firm-specific, time-invariant variables that can be assumed to capture a significant part of present fixed effects (e.g. country, industry indicators, functional dummies, etc.). Hence a random-effects specification seems to be a priori more appropriate.

However, Hausman tests for FE versus RE modeling undertaken for the models reported below (not reported here) tend to reject the null of consistency in the RE modeling – consequently the reported FE model should be considered more reliable. Estimations and results are summarized below.

European manufacturing and automotive suppliers

Firstly, I investigated the principal effect of R&D spending on sales, total profits and the profits attributable to intangible assets. This allows drawing conclusions about the influence of R&D/sales shares on profit margins. Profits attributable to intangible assets are calculated, following Clarkson's methodology, as the residual profit after taxes once the market return for other capital used, i.e. fixed and working capital, has been accounted for. Estimations yielding the following results are reported in Tables 3.1. and 3.2.

1) A one-percent increase in R&D spending tends to increase sales by 0.27 percent for European manufacturing firms and 0.49 percent for European automotive suppliers.

2) A one-percent increase in R&D spending tends to increase EBIT by 0.44 percent for European manufacturing firms and 0.61 percent for European automotive suppliers.

3) A one-percent increase in R&D spending tends to increase PIA, the profit contribution by intangible assets, by 0.45 percent for European manufacturing firms and 0.54 percent for European automotive suppliers.

All relations have been estimated with RE models using logs in the variables and they explain 60-80% of the sales variation and 50-60% of the profit variation in the data.

These estimates show that R&D increases tend to increase profits by a larger percentage than sales; it follows that an increase in the R&D/sales ratio by one percent tends to increase the profit margin by 0.1 to 0.17 percent and the margin of intangible asset profits by 0.05 to 0.18 percent.

Secondly, the principal effect of R&D spending on intangible asset levels and asset/sales ratios was investigated. See Tables 3.1. and 3.2. for details.

1) A one-percent increase in R&D spending tends to increase intangible asset values by about 0.45 percent for both European manufacturing firms and European automotive suppliers.

2) A one-percentage point increase in the R&D/sales share tends to increase the intangible asset value to sales share by up to 0.1 percentage points for both European manufacturing firms and European automotive suppliers.

All relations have been estimated with RE models using logs in the variables and they explain 30% of the intangible asset values variation in the data.

Thirdly, the effects of increasing intangible assets on sales and profits are analyzed. This allows drawing conclusions about the influence of ratio of intangible assets to sales on profit margins. See Tables 3.1. and 3.2. for details.

4) A one-percent increase in intangible asset values tends to increase sales by 0.1 percent for both European manufacturing firms and European automotive suppliers.

5) A one-percent increase in intangible asset values tends to increase EBIT by 0.2 percent for European manufacturing firms and 0.33 percent for European automotive suppliers.

All relations have been estimated with RE models using logs in the variables and they explain 30-60% of the variation in the data.

These estimates show that intangible asset increases tend to increase profits by a larger percentage than sales; it follows that an increase in the intangible asset/sales ratio by one percent tends to increase the profit margin by 0.1 to 0.13 percent.

North American automotive suppliers

In a first exercise, I investigated the principal effect of R&D spending on profit, sales, and profits attributable to intangible assets. Estimations yielding the following results are reported in Table 1.1.

1) A one-percent increase in R&D spending tends to increase EBIT by ½ to ¾ percent

2) A one-percent increase in R&D spending tends to increase sales by 0.1 to 0.4 percent

3) A one-percentage point increase in R&D-sales ratio tends to increase the EBIT-sales margin by ¼ to 1/2 percentage points

The first two relations have been estimated with IV RE and FE models using logs in the variables and they explain over 80% of the EBIT variation and over 90% of the sales variation in the data.

In a second exercise, I follow Clarkson's methodology in order to isolate the effect of R&D spending on the value of intangible assets and the return to intangible assets. According to the step-by-step procedure applied, I report several sets of regressions:

1) Regressions in logs show that R&D increases EBIT and sales, but EBIT by a larger percentage. These regressions explain at least 80% of variation in all model setups. It follows that R&D increases the EBIT margin! The corresponding estimations are reported in the first four models in Tables 4.1. and 4.2., respectively.

2) Additional regressions of EBIT-sales margin against lagged R&D expenditure as share of sales show that past R&D-sales ratios significantly influence present EBIT-sales margins. The corresponding estimations are reported in the last two models in Tables 4.1. and 4.2., respectively.

3) Regressions of intangible asset levels (measured as total assets minus tangible and current assets) against past R&D levels indicate that past R&D explains at 75% of current intangible asset values. Intangible asset values are increasing in R&D! Undertaking the regressions from set 3 with sales ratios also yields significant positive results with the R&D-sales ratio explaining about a quarter of the intangible-asset-sales ratio. The corresponding estimations are reported in Table 4.3.

4) Lastly, CPIA – contributions to profit by intangible asset – values following the method of Clarkson have been calculated. The wacc/roe calculations were done following Damodaran (2011) and Lutz (2012) where roe= tbond-rate +alpha*risk and risk is measured as the individual firm's volatility of returns to capital. Here the results show a stable positive relationship between the R&D-sales ratio and CPIA. The corresponding estimations are reported in Table 4.4.

According to the model estimates, an increase of one percentage point in the R&D to sales ratio increases the profit contributions of intangible assets by 1/4 to 1.25 percent of sales. The models explain between one third and half of the variation in the profit contributions of intangible assets.

6. Conclusions

According to the analyses presented R&D expenses tend to increase both intangible asset levels and their profit contributions for European and North American firms in the automotive supplier industry. For European firms the same mechanisms have also been observed for the manufacturing sectors as whole.

For the North American automotive supplier industry there is also strong evidence that firms' profit margins and profits attributable to intangible assets as a share of sales increase with increasing R&D/sales shares.

For European firms the effects of increasing R&D/sales shares on firms' profit margins and profit/sales shares attributable to intangible assets could not be directly measured, possibly due to a lack of European R&D expense data. More research is warranted here, for example by collecting independent R&D information for European firms and revisiting the analysis presented above with more complete data.

On the whole, these results provide a rationale for observed pricing behavior of firms licensing intangible assets to other firms, where licensors and licensees negotiate royalty rates to target a stable profit split and therefore a stable positive relationship between profit (shares) and royalties can be observed: higher R&D intensities should then lead to higher royalty rates.

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Appendix

Table 1. Data sources

#	Data type	Source	Downloaded / data	Date
1	North American firm data (balance sheet, profit/loss)	Wharton Research Data Services (WRDS)[1]: Compustat	https://wrds-web.wharton.upenn.edu/wrds/ (Data set: compm/funda/ ann / Jan 1950 - Jan 2012, TIC, all, NAICS ge 33000 and NAICS lt 34000)	21 August 2012
2	European firm data (balance sheet, profit/loss)	Wharton Research Data Services (WRDS): Amadeus	https://wrds-web.wharton.upenn.edu/wrds/ (Data set: bvd/financials /ann / 1980 – 2013, IDNR, all)	23 May 2013
3	Short-term and long-term interest rate data	International Monetary Fund: International Financial Statistics	http://dx.doi.org/10.5257/imf/ifs/2012-08. Annual IFS series. Table title: United States, series 60C..ZF, 61..ZF.	August 2012 and May 2013

[1] Wharton Research Data Services (WRDS) was used in preparing part of the data set used in the research reported in this paper. This service and the data available thereon constitute valuable intellectual property and trade secrets of WRDS and/or its third-party suppliers.

Table 2. List of variables

Variable	Definition
act	Current Assets - Total
re	Retained Earnings
am	Amortization of Intangibles
tlcf	Tax Loss Carry Forward
at	Assets - Total
ebit	Earnings Before Interest and Taxes
ni	Net Income (Loss)
ppegt	Property, Plant and Equipment - Total (Gross)
sale	Sales/Turnover (Net)
txt	Income Taxes - Total
xrd	Research and Development Expense
mkvalt	Market Value - Total - Fiscal
loc	Current ISO Country Code - Headquarters
naicsn	North American Industry Classification Code
sic	Standard Industry Classification Code
state	State/Province
ebiat	ebit-txt
seq	Shareholder equity
rshf	ni/seq
std3rshf	3-period standard deviation of rshf
xrds	xrd/sale
countryn	group(loc)
roe	tbond+0.3*std3rshf
da	1-seq/at
wacc	da*(1-0.4)*tbill+(1-da)*roe
ai	mkvalt-act-ppegt
ais	ai/sale
margin	ebit/sale
ria	(wacc-act/mkvalt*tbill-ppegt/mkvalt*tbond)/(ai/mkvalt)
cpia	ai/mkvalt*ria/wacc*ebiat/sale or EBIAT - (act*tbill-ppegt*tbond)/100
pia	cpia*sale
tbond	Treasury bill rate, percent per annum*100
tbill	Ten year government bond yield, percent per annum*100
ln_var	ln(_var)
var_s	_var/sale

Table 3.1. European Manufacturing: Effects of R&D and intangible assets

Model	(3.1.1) RE	(3.1.2) RE	(3.1.3) RE	(3.1.4) RE	(3.1.5) RE	(3.1.6) RE	(3.1.7) RE
Dep. Variable	lnsale	lnebit	lnpia	lnai	ais	lnsale	lnebit
lnxrd(-1)	0.2723 ***	0.4369 ***	0.4480 ***	0.4290 ***			
xrds (-1)					0.0056 ***		
lnai(-1)						0.0920 ***	0.2082 ***
Observations	3345	2735	2337	2019	6564	3843	3220
Groups (Firms)	1326	1185	1098	766	2032	1280	1157
R-sq. within	0.0031	0.0000	0.0061	0.0035	0.0064	0.1305	0.0274
R-sq. between	0.5016	0.4601	0.4467	0.2989	0.0017	0.2169	0.2595
R-sq. overall	0.5836	0.4920	0.4849	0.2963	0.0029	0.2881	0.2934
Prob > chi2 (>F)	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000	0.0000

Notes. (i) Variables pia and ai denote profits attributable to intangible assets and intangible assets, respectively; (ii) All models estimated with random effects. (iii) All equations include a constant and yearly effects; (iv) *** denotes significant at the 1%, ** at the 5%, * at the 10% level.

Table 3.2. European Automotive: Effects of R&D and intangible assets

Model	(3.2.1) RE	(3.2.2) RE	(3.2.3) RE	(3.2.4) RE	(3.2.5) RE	(3.2.6) RE	(3.2.7) RE
Dep. Variable	lnsale	lnebit	lnpia	lnai	ais	lnsale	lnebit
lnxrd(-1)	0.4938 ***	0.6081 ***	0.5434 ***	0.4431 ***			
xrds (-1)					0.3162 ***		
lnai (-1)						0.0876 ***	0.3307 ***
Observations	175	117	94	101	386	183	126
Groups (Firms)	58	49	42	33	96	56	47
R-sq. within	0.0200	0.0112	0.0018	0.0061	0.0381	0.0003	0.0018
R-sq. between	0.7882	0.6956	0.6745	0.2956	0.0086	0.5055	0.3947
R-sq. overall	0.8319	0.6139	0.6351	0.3177	0.0167	0.5010	0.2620
Prob > chi2 (>F)	0.0000	0.0000	0.0000	0.0015	0.0030	0.0142	0.0000

Notes. (i) Variables pia and ai denote profits attributable to intangible assets and intangible assets, respectively; (ii) All models estimated with random effects. (iii) All equations include a constant and yearly effects; (iv) *** denotes significant at the 1%, ** at the 5%, * at the 10% level.

Table 4.1. North American Automotive: Effects of R&D on EBIT, sales, and margins (1)

Model	**(4.1.1) IV-FE**	**(4.1.2) IV-RE**	**(4.1.3) IV-FE**	**(4.1.4) IV-RE**	**(4.1.5) RE**	**(4.1.6) FE**
Dep. Variable	**lnebit**	**lnebit**	**lnsale**	**lnsale**	**margin**	**margin**
lnxrd	**0.7434*** **	**0.5640*** **	**0.4445*** **	**0.0792*** **		
lnebit (-1)	**0.0984** **	**0.4286*** **				
lnsale (-1)			**0.4443*** **	**0.9064*** **		
margin (-1)					**0.1684*** **	**0.2653*** **
xrds (-1)					**0.2731*** **	**0.5391*** **
Observations	**1252**	**1252**	**1602**	**1602**	**31741**	**31741**
Groups (Firms)	**384**	**384**	**467**	**467**	**2725**	**2725**
R-sq. within	**0.3597**	**0.3464**	**0.8506**	**0.8453**	**0.0110**	**0.0145**
R-sq. between	**0.8068**	**0.8894**	**0.9349**	**0.9861**	**0.0127**	**0.0006**
R-sq. overall	**0.8243**	**0.8864**	**0.9499**	**0.9892**	**0.0191**	**0.0106**
Prob > chi2 (>F)	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Notes. (i) Models (1), (3), and (6) estimated with fixed effects; Models (2), (4) and (5) estimated with random effects. Models (1) to (4) IV regressions with lnxrd instrumented by lagged observations of lnre, lnam, lntlcf and other variables. (ii) All equations include a constant. (iii) *** denotes significant at the 1%, ** at the 5%, * at the 10% level.

Table 4.2. North American Automotive: Effects of R&D on EBIT, sales, and margins (2)

Model	(4.2.1) FE	(4.2.2) FE	(4.2.3) RE	(4.2.4) RE	(4.2.5) FE	(4.2.6) RE
Dep. Variable	**lnebit**	**lnsale**	**lnebit**	**lnsale**	**margin**	**margin**
lnxrd (-1)	0.2547***	0.1067***	0.2253***	0.0805***		
lnebit (-1)	0.5036***		0.6480***			
lnsale (-1)		0.7367***		0.8178***		
margin (-1)					0.1907***	0.2136***
xrds (-1)					0.3934***	0.3946***
xrds (-2)					-0.0010	-0.0220***
xrds (-3)					0.0069	0.0000
Observations	29769	47515	29769	47515	39921	39921
Groups (Firms)	2985	4056	2985	4056	3491	3491
R-sq. within	0.5165	0.7890	0.5143	0.7884	0.0051	0.0037
R-sq. between	0.9123	0.9677	0.9240	0.9688	0.0000	0.0364
R-sq. overall	0.8690	0.9617	0.8755	0.9632	0.0012	0.0057
Prob > chi2 (>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes. (i) Models (1), (2), and (5) estimated with fixed effects; Models (2), (3) and (6) estimated with random effects. (ii) All equations include a constant. (iii) *** denotes significant at the 1%, ** at the 5%, * at the 10% level.

Table 4.3. North American Automotive: Effects of R&D on intangible assets

Model	(4.3.1) FE	(4.3.2) RE	(4.3.3) FE	(4.3.4) FE	(4.3.5) RE	(4.3.6) RE
Dep. Variable	**lnai**	**lnai**	**ais**	**ais**	**ais**	**ais**
lnxrd (-1)	0.0881***	0.5277***				
xrds			6.1616***	7.8259***	6.3858***	8.2368***
xrds (-1)			-0.3285***		-0.1039	
xrds (-2)			2.1246***		2.1011***	
Observations	10217	10217	16481	17676	16481	17676
Groups (Firms)	1940	1940	2330	2462	2330	2462
R-sq. within	0.0026	0.0026	0.2876	0.0879	0.2873	0.0879
R-sq. between	0.5837	0.5837	0.2127	0.1865	0.2171	0.1865
R-sq. overall	0.5384	0.5384	0.2806	0.1376	0.2817	0.1376
Prob > chi2 (>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes. (i) Variable ai denotes intangible assets; (ii) Models (1), (3), and (4) estimated with fixed effects; Models (2), (5) and (6) estimated with random effects. (iii) All equations include a constant. (iv) *** denotes significant at the 1%, ** at the 5%, * at the 10% level.

Table 4.4. North American Automotive: Effects of R&D on profit margins attributable to intangible assets

Model	(4.4.1) FE	(4.4.2) FE	(4.4.3) FE	(4.4.4) RE	(4.4.5) RE	(4.4.6) RE
Dep. Variable	**cpia**	**cpia**	**cpia**	**cpia**	**cpia**	**cpia**
cpia (-1)	0.0296***	0.0296***	0.0296***	0.7465***	0.7465***	0.7465***
xrds (-1)	0.3582***	0.3083***	0.2619***	1.1250***	1.1203***	1.0999***
xrds (-2)	0.2616	0.1162		-0.2294	-0.2898*	
xrds (-3)	0.0017			-0.0549		
Observations	12928	13145	13333	12928	13145	13333
Groups (Firms)	1919	1961	1985	1919	1961	1985
R-sq. within	0.0042	0.0032	0.0024	0.0007	0.0007	0.0007
R-sq. between	0.6235	0.7446	0.8545	0.9864	0.9875	0.9877
R-sq. overall	0.2409	0.2973	0.3563	0.5731	0.5731	0.5727
Prob > chi2 (>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes. (i) Variable cpia denotes profits margins attributable to intangible assets; (ii) Models (1), (2), and (3) estimated with fixed effects; Models (4), (5) and (6) estimated with random effects. Models (1) to (4) IV regressions with lnxrd instrumented by lagged observations of lnre, lnam, lntlcf and other variables. (iii) All equations include a constant. (iv) *** denotes significant at the 1%, ** at the 5%, * at the 10% level.